

# Status and ethno-medicinal usage of invasive plants in traditional health care practices: a case study from northeastern Bangladesh

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**Abstract:** Species diversity and ethno-medicinal usage of 39 species of invasive plants were explored in and around two protected areas, Khadimnagar National Park (KNP) and Rema-Kalenga Wildlife Sanctuary (RKWS), of northeastern Bangladesh. Status of invasive plants were investigated in 60 sample plots with 5 different habitat types, including forest, roadside, homestead, fallow land and others (ponds, canals, water logged areas, agricultural land, etc.). Data about the usage of invasive plants in traditional health care were collected through interviewing 110 households. Among the five habitat types, fallow land (28 species) possessed the highest number of species, followed by roadside (25 species), forest (23 species), homestead (22 species) and others (13 species). Based on the survey, invasive plants of study areas were also categorized into five degrees of invasiveness e.g., naturalized, introduced, possibly invasive, moderately invasive and highly invasive. Additionally, there is the linear trend between degrees of invasiveness and use percentage of invasive plants. Total 39 species of invasive plants belonging to 29 families were recorded, which are generally used to treat 37 diseases, ranging from simple headache to highly complicated eye and heart diseases. The majority of the species used by the local inhabitants were herbs (16 species), followed by some shrubs (11 species), climbers (5 species), trees (5 species) and grasses (2 species). The use percentage of aboveground plant parts were higher (70.58%) than that of underground plant parts (16.18%).

**Keywords:** diversity; usage; invasive species; medicinal plants; ethno-medicine; protected areas

## Introduction

About 80% of the population in the developing countries depends on plant products for their primary healthcare (Farnsworth and Soejarto 1991; Pei 2001; Mukul et al. 2007). Traditionally, indigenous communities possess knowledge about usage of plants and other natural resources on which they are immediately dependent (Khisa 1998). This knowledge is known as indigenous knowledge (IK), which plays a central role in disease diagnosis and healthcare practices in traditional medication systems. Although indigenous knowledge on medicinal uses of native plants is well documented (Khan et al. 2009), very little is known about the medicinal uses of invasive plants (Mooney 2001).

Bangladesh, due to its location, productive soils, favorable climate and seasonal diversity supports a vast variety of flora, including medicinal plants. Of more than 5700 angiosperms in the country, more than 500 have medicinal properties (Yusuf et al. 1994; Dixie et al. 2003; Ghani 2004; Hossain 2005). Very few authors deal with medicinal uses of invasive species and their natural habitat in Bangladesh (Mukul et al. 2008; Biswas et al. 2007; Zuberi and Akter 2007; Bhuiya 2004; Biswas 2003; Islam et al. 2003; Barua et al. 2001; Hossain and Pasha 2001; Rahman 1997). It is true that invasive plants have some negative impacts on local ecosystems (Bhuiyan 2004; Binggeli et al. 1998), but not all of them are harmful. In Bangladesh, *Eichhornia crassipes* (Mart) solms. (water hyacinth), one of the major invasive plant species can considerably reduce the arsenic contaminants from water and render it unobjectionable for human drinking (Kathryn 2005). While some invasive plants have medicinal properties, it is essential to document the medicinal usage of other invasive plants.

In Bangladesh, various research works have been done to identify the invasive species and their impact on ecosystem and biodiversity, but no study was so far carried out solely on the status, diversity and traditional usage of invasive plants for me-

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dicinal purposes. The present study aimed to assess the diversity and traditional uses of invasive plants for medicinal purposes. This paper further attempted to explore the using pattern of these invasive plants for health care practices through indigenous knowledge in and around two protected areas namely, Khadimnagar National Park and Rema-Kalenga Wildlife Sanctuary of Northeastern Bangladesh.

## Methods

### Study area

The study was conducted in and around two protected areas, Khadimnagar National Park (KNP) and Rema-Kalenga Wildlife Sanctuary (RKWS) (Fig. 1). These areas were selected pur-

posively considering their unique geo-physical features, richness in biological diversity and households' dependency on forest resources. KNP is located at North Sylhet Range-1 and RKWS is located at Habigonj -2 range in Sylhet Forest Division under tropical evergreen and semi-evergreen bio-geographic zone. Geographically KNP lies between  $24^{\circ}56' - 24^{\circ}58'N$  and  $91^{\circ}55' - 91^{\circ}59'E$  (Rahman 2006). However, RKWS lies between  $24^{\circ}06' - 24^{\circ}14' N$  and  $91^{\circ}34' - 91^{\circ}41' E$ . Total areas of KNP and RKWS are 679 ha and 1995 ha respectively (Rahman 2006). The hills of these areas are generally low and gently sloping. Soil ranges from clay loams to pale brown (acidic) clay loams on the hills (Rahman 2006). The tropical monsoon climate prevails in the area with average maximum temperature of  $30.7^{\circ}C$  and average minimum temperature of  $18.9^{\circ}C$ . The average annual rainfall is 3931 mm, most of which falls between June-September (BBS/UNDP 2005).

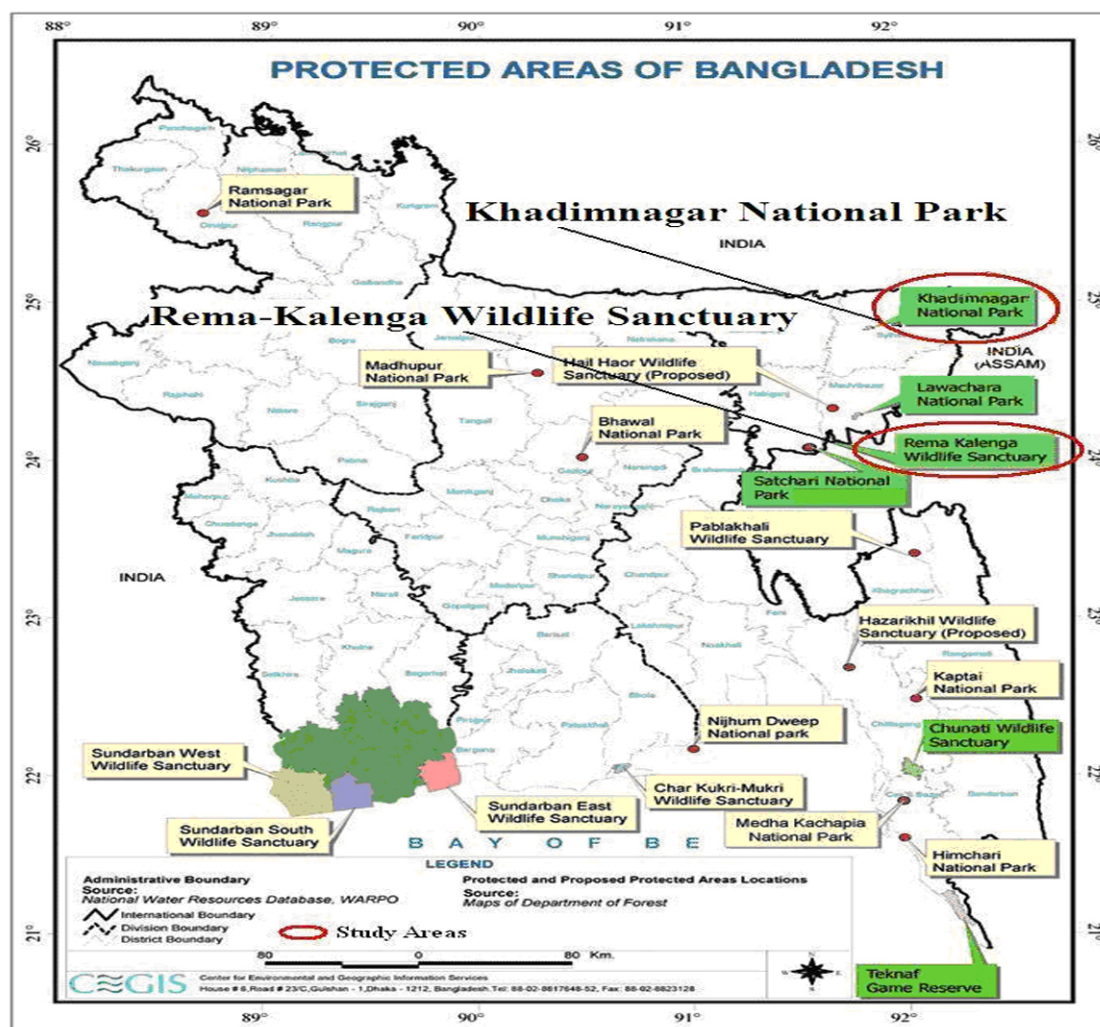


Fig. 1 Location of the study areas (Adapted from NSP 2006)

The present study was conducted in two phases namely, respondent survey and plot survey from different habitats in the study areas. Respondent survey was carried out at the first phase and plot survey at the second phase. Equal number of respon-

dents and sample plots (Table 1) were selected from two study areas. Sample plots in the study areas were selected from five different habitats namely; forest, roadside, homestead, fallow land and others (ponds, canals, water logged areas, agricultural

land, etc.).

**Table 1. Number of respondents and selected sample plots of 60 from two study areas**

Items	Khadimnagar National Park	Rema-Kalenga Wildlife Sanctuary
Respondent*	55	55
Forest	6	6
Roadside	6	6
Homestead	6	6
Fallow land	6	6
Others	6	6

**Notes:** “\*” means that number of respondents are 110 in total.

#### Data collection from respondents

Mainly experienced persons (at age of 40 to 90) were interviewed from two protected areas, Khadimnagar National Park (KNP) and Rema-Kalenga Wildlife Sanctuary (RKWS). In total of 110 respondents, 55 from each study area were selected for interview. Respondents were selected purposively considering their medicinal knowledge and practices. A semi-structured questionnaire was used to collect data on status, utilization and sources of invasive plants. Respondents were also asked about mostly used plant parts for different ailments and their methods of medicine preparation. Furthermore, degrees of invasiveness of invasive plants were also measured through respondents' opinion. A list of 39 species of invasive medicinal plants in the study area was provided to each respondent and was asked to sort all invasive medicinal plants separately into 5 pre-selected categories namely, naturalized, introduced, possibly invasive, moderately invasive and highly invasive. Finally, the category of degree of invasiveness for each species was fixed by the highest opinion of respondents. Thus opinions regarding the degrees of invasiveness for 39 species of invasive plants were taken from 110 respondents. Detailed information was noted during interviews and information gaps were amended through additional visits and cross-checking. Data collected from the respondents were cross checked through interviewing 5 *kabiraj* (local traditional healers living and working in the study areas) who were practiced on herbal medicine.

#### Data collection from sample plot

In total of 60 sample plots, 12 from each habitat were randomly selected for study. Circular plots of 10-m radius were used as sample plot. The species names of all individuals were recorded for invasive trees, shrubs, herbs, climbers and grasses in circular plots.

## Results and discussion

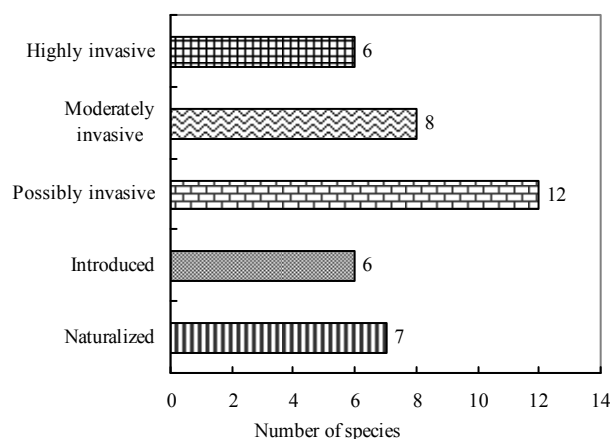
During our field investigations, a total of 39 species of invasive medicinal plants belonging to 29 families were recorded for sci-

entific name, local name, family, habit, main sources, degree of invasiveness, use frequency and the suspected origin (see Appendix 1). Most of them belong to Convolvulaceae (4 species) family, followed by Asteraceae (3 species), Verbenaceae (3 species), Leguminosae (2 species), Amaranthaceae (2 species), Myrtaceae (2 species) and Polygonaceae (2 species), which were found to have frequent use. Single species was found from Apocynaceae, Cimpositae, Poaceae family and from 19 other families. Rana et al. (2010), Chowdhury et al. (2009), Uddin et al. (2008) and Mukul et al. (2007) also recorded that the species under the Combretaceae, Apocynaceae, Piperaceae and Rubiaceae families are frequently used as medicinal plants.

The present study also explored the DI of the invasive medicinal plants. Among 39 species, 12 species were under the category of ‘possibly invasive’, followed by ‘naturalized’ (7 species) and ‘moderately invasive’ (8 species). However, the lowest number of species belongs to the category ‘introduced’ (6 species) and ‘highly invasive’ (6 species) (Fig. 2). The most interesting result of the study is that use frequency of the invasive medicinal plants was decreased with the increases of their degree of invasiveness. In addition, linear trend line (Equation 1) indicates that peoples of the study areas mostly use those invasive plants, which have low DI. This tendency is decreased with the increase of DI of invasive plants (Fig. 3).

$$y = -6.4242x + 51.503 \quad (1)$$

where,  $y$  denotes percentage of use frequency;  $x$  denotes DI of invasive plants.



**Fig. 2 Species of invasive medicinal plants based on degree of invasiveness**

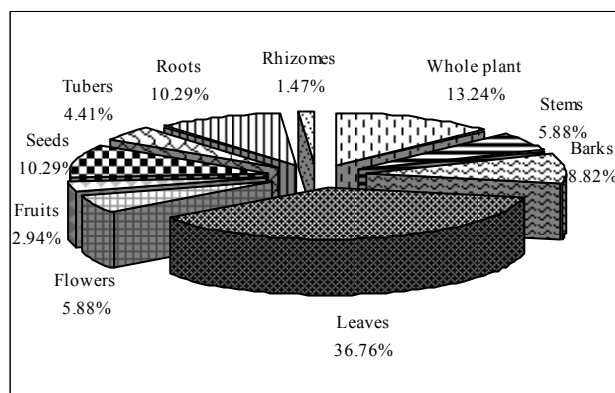
Majority of the species of invasive medicinal plants used by the local inhabitants were herbs (16 species), followed by some shrubs (11 species), climbers (5 species), trees (5 species) and grasses (2 species) in the study areas (Table 2). Some researchers also found similar results that herb species were dominated in the observed medicinal plant species (Rana et al. 2009; Halim et al. 2007; Ghani 2004). But others found that tree species was dominant medicinal plants in their study areas (Rana et al. 2010; Khan et al. 2009; Uddin et al. 2008; Mukul et al. 2008). Results

also revealed that frequency of occurrence of species varied according to 5 different habitats in the study areas. Among these 5 habitats, diversity of collecting invasive medicinal plant's species was highest in fallow-land (28 species), followed by roadside (25 species), forest (23 species), homestead (22 species) and others site (13 species). Results of this paper also indicate that diversities of herbs (13 species) and shrubs (10 species) were highest in the fallow-land. However, number of trees (4 species) was highest in the forest (Table 2). Various researchers (Khan et al. 2009 and Mukul et al. 2007) explored that forest was the main source of collecting medicinal plants, followed by homestead and agricultural lands. But Halim et al. (2007) observed that people preferred to collect medicinal plants in wild sources (village groves, jungles, graveyards, roadsides and pond banks) and Chowdhury et al. (2009) found that most common source of medicinal plants was the respondents' homestead.

**Table 2.** Diversity of invasive medicinal plants at different habitats in the study areas

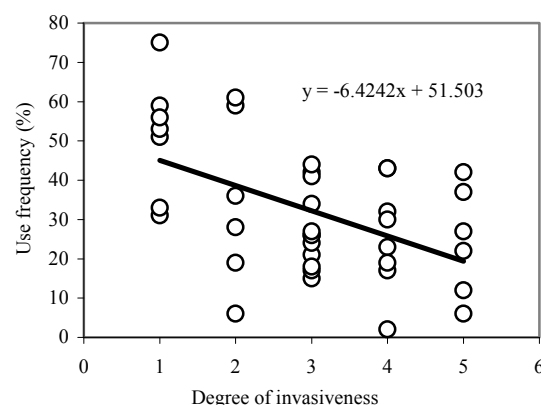
Plot location	Herbs n=16(41.03)	Shrubs n=11(28.21)	Climbers n=5(12.82)	Grasses n=2(5.13)	Trees n=5(12.82)	Total no. of spp. N=39 (100)
Fallow-land	13 (33.33)	10 (25.64)	3 (7.69)	2 (5.13)	0 (00)	28 (71.79)
Forest	9 (23.08)	6 (15.38)	3 (7.69)	1 (2.56)	4 (10.26)	23 (58.97)
Homestead	7 (17.95)	6 (15.38)	4 (10.26)	2 (5.13)	3 (7.69)	22 (56.41)
Roadside	9 (23.08)	7 (17.95)	4 (10.26)	2 (5.13)	3 (7.69)	25 (64.10)
Others	6(15.38)	3 (7.69)	2 (5.13)	1 (2.56)	1 (2.56)	13 (33.33)

**Note:** Values in the parenthesis indicate the percentage.  $N = (\sum n_i)$ .  $N$  indicates the total number of species.



**Fig. 4** Different plant parts used in the study areas for preparation of different medicines

Both above-and belowground plant parts are used as herbal medicine in the study area. For medicinal preparations, people mostly use above-ground plant parts (70.57%), followed by below-ground parts (16.17%) and whole plants (13.26%). Of the above-ground plant parts, most frequently used parts are leaves (36.76%), followed by seeds (10.29%), bark (8.82%), flowers (5.88%), stems (5.88%) and fruits (2.94%), (Fig. 4). The predominant use of leaves was also reported by researchers (e.g. Uddin et al. 2009; Khan et al. 2009; Halim et al. 2007; Mukul et al. 2007; Uddin and Khan 2007; Sajem and Gosai 2006; Gazzaneo et al. 2005). However, Lulekal et al. (2008) in southeastern



**Fig. 3** Use frequency (UF) of different species of invasive plant according to degree of invasiveness

Ethiopia found that local people mostly used roots of medicinal plants. Halim et al. (2007) explored that abundant use of leaves ensured sustainable harvesting of medicinal plants. Schippmann et al. (2002) suggested that this also provided an incentive to protect and maintain wild populations and their habitats as well as the genetic diversity of such medicinal plants. In most cases, the paste and juice made from leaves and barks are used as medicines, while fruits are eaten raw. Different below-ground plant parts such as roots (10.29%), tubers (4.41%) and rhizomes (1.47%) are also used to treat ailments in the study areas (Fig. 4).

The diverse patterns in the use of different parts of invasive medicinal plants show that rural people had a high level of indigenous knowledge regarding their health care practices. The major uses of invasive medicinal plants mentioned by the respondents are summarized in Appendix 2. Most plant parts are consumed orally after processing such as macerating, squeezing, grinding, blending, soaking or boiling in water, milk or mustard oil, rubbing or burning. Some are taken raw. Some are applied externally to different body parts for cuts and wounds, scabies, joint pain, piles, skin diseases, etc. Invasive plants identified in the study areas are used to treat 37 kinds of diseases, including simple headaches, highly complicated eye diseases, heart diseases, jaundice, diabetes and constipation, etc. (Table 3). Medicinal plants are generally used to treat fever, coughs, cuts and wounds, cold ailments, teeth ache, hair loss, skin diseases, joint pain, stop bleeding, dysentery and diarrhea. Similar results were found by Khan et al. (2009) and Mukul et al. (2007). The largest numbers of invasive species of medicinal plants are used for

treating skin diseases, 7 species for diarrhea and stop bleeding, and other species for joint pain, dysentery, cut and wounds, teeth ache, scabies, rheumatism, fever, liver problem, eye diseases,

constipation, antiseptic, etc. (Table 3). In some cases, a mixture of several species is also used in the study areas.

**Table 3. Different uses of invasive medicinal plants for different ailments**

Sl. No.	Name of ailments	No. of species reported					Total	Percentage of use (%)
		Tree	Herb	Shrub	Climber	Grass		
1	Anti-allergic	0	1	1	0	0	2	1.48
2	Antiseptic	0	3	2	0	0	5	3.70
3	Asthma	1	1	2	0	0	4	2.96
4	Body ache	0	0	1	0	1	2	1.48
5	Bronchitis	1	0	0	0	0	1	0.74
6	Cardiac tonic	0	1	0	0	0	1	0.74
7	Cold ailments	2	1	1	0	0	4	2.96
8	Constipation	1	1	1	2	0	5	3.70
9	Cough	2	2	0	0	0	4	2.96
10	Cut and wounds	0	1	2	1	1	5	3.70
11	Diarrhea	0	4	2	0	1	7	5.19
12	Diabetes	0	0	1	0	1	2	1.48
13	Dysentery	0	4	2	0	0	6	4.44
14	Ear ache	0	1	1	0	0	2	1.48
15	Eye disease	1	2	0	1	0	4	2.96
16	Fever	0	2	2	1	0	5	3.70
17	Gastric pain	0	2	1	0	0	3	2.22
18	Hair fall	1	0	0	1	0	2	1.48
19	Headache	1	1	1	0	0	3	2.22
20	Heart disease	0	1	0	0	0	1	0.74
21	Inflammation	1	1	0	0	0	2	1.48
22	Insect bites	0	1	1	0	0	2	1.48
23	Jaundice	0	2	1	1	0	4	2.96
24	Joint pain	2	2	0	0	0	4	2.96
25	Liver problem	0	3	1	1	0	5	3.70
26	Mental depression	0	1	0	1	0	2	1.48
27	Piles	0	3	0	0	0	3	2.22
28	Rheumatism	0	2	1	2	0	5	3.70
29	Scabies	1	3	1	0	0	5	3.70
30	Skin diseases	1	5	6	2	0	14	10.37
31	Spleen disease	0	1	0	0	0	1	0.74
32	Stomach problem	1	1	0	0	0	2	1.48
33	Stop bleeding	0	2	3	1	1	7	5.19
34	Teeth ache	1	1	1	0	1	4	2.96
35	Urinary problem	1	1	0	0	0	2	1.48
36	Vomiting	0	1	0	0	0	1	0.74
37	Worms	0	1	2	0	1	4	2.96
Total		18	59	37	14	7	135	100

## Conclusion

Our study revealed that the people living in and around the study areas used invasive plant species for their traditional health care practices. In the study areas, there were 39 species of invasive medicinal plants from 5 different habitats. This may imply that there was the rich diversity of invasive plants in their surrounding habitats. Invasive plants were used to treat 37 diseases in the

study areas. The respondents had a rich traditional knowledge regarding the ethno-medicinal uses for these plants. The using pattern of invasive plants in this paper may be helpful for other peoples to use these plants in their traditional health care practices, which may minimize the pressure of using native medicinal plants. The present study in and around two forest areas is a small sample for exploring the actual thing. Different results might be found in the other forest areas. Further study is highly recommended to reexamine the present findings.

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## Appendix 1: List of invasive medicinal plants in and around the study areas

Scientific name	Local name	Family	Main sources	Habit	DI <sup>1</sup>	UF <sup>2</sup> (%)	Suspected origin and reference(s)
<i>Achyranthes aspera</i> Linn.	Apang	Amaranthaceae	Fallow-land, Forest, Homestead	Herb	1	51	Exact native range obscure (USDA/ARS/GRIN 2010)
<i>Ageratum conyzoides</i> L.	Dochondi	Compositae	Fallow-land, Homestead, Roadside	Shrub	3	21	Native in central and south America (Raizada 2007)
<i>Albizia falcataria</i> L.	Malakanna Koroï	Leguminosae	Forest, Others, Roadside	Tree	2	19	Eastern Island of Indonesia, New Guinea, South East Asia from Myanmar & Philippines (Ahmed et al. 2009b)
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Helencha	Amaranthaceae	Fallow-land, Others	Herb	3	42	Tropical Africa, Brazil (Islam 1985; Karim et al. 1995; Ahmed et al. 2008a)

**Continued Appendix 1**

Scientific name	Local name	Family	Main sources	Habit	DI <sup>1</sup>	UF <sup>2</sup> (%)	Suspected origin and reference(s)
<i>Argemone mexicana</i> Linn.	Shialkanta	Papveraceae	Fallow-land, Forest, Roadside	Herb	3	15	Tropical America and Mexico (Islam 1985; Karim et al. 1995; Ahmed et al. 2009b)
<i>Bacopa monniera</i> (L.) Pennel	Brahmi shak	Scrophulariaceae	Fallow-land, Forest, Homestead, Roadside	Herb	1	31	Tropics and sub tropics (Ahmed et al. 2010)
<i>Bryophyllum pinnatum</i> (Lamk.) Oken	Pathur kuchi	Crassulaceae	Homestead, Roadside	Herb	1	56	Madagascar (Ahmed et al. 2008b)
<i>Cassia occidentalis</i> L.	Kala Ka-shunda	Caesalpiniaceae	Fallow-land, Homestead, Others	Shrub	3	24	Native to South America (Ahmed et al. 2008b)
<i>Centella asiatica</i> (L.) Urban	Thankuni	Hydrocotylaceae	Fallow-land, Homestead, Roadside	Herb	1	75	Tropics and sub-tropics (Ahmed et al. 2008a)
<i>Chromolaena odorata</i> (L.) King & Robinson	Asam pata	Asteraceae	Homestead, Forest, Fallow-land, Roadside	Shrub	4	43	West Indies, tropical America (Ahmed et al. 2008a)
<i>Clerodendrum viscosum</i> Vent.	Bhat pata	Verbenaceae	Homestead, Fallow-land, Forest, Roadside	Shrub	4	2	India, Myanmar, Thailand, China, Indonesia, Sri Lanka, Philippines (Ahmed et al. 2010)
<i>Croton bonplandianus</i> Baill.	Bon Morich	Euphorbiaceae	Fallow-land, Forest, Roadside	Shrub	3	17	South America (Islam 1985) and Tropical and Subtropical regions (Ahmed et al. 2008b)
<i>Cuscuta reflexa</i> Roxb.	Shornolata	Convolvulaceae	Forest, Homestead, Roadside	Climber	5	37	Europe, North America (Machado and Zetsche 1990; Costea et al. 2006)
<i>Cyathea gigantea</i> Wall	Tree fern	Cyatheaceae	Forest, Others	Shrub	3	26	Eastern Himalayas, Laos, South China, Vietnam (Mirza et al. 1997; Siddiqui et al. 2007)
<i>Cynodon dactylon</i> (L) Pers.	Durba grass	Poaceae	Fallow-land, Forest, Homestead, Roadside	Grass	4	43	North Africa, Asia, Australia and southern Europe (Wikipedia 2010)
<i>Cyperus rotundus</i> L.	Mutha	Cyperaceae	Fallow-land Homestead, Others, Roadside	Grass	3	18	Tropical Africa (Islam 1985)
<i>Dalbergia sissoo</i> Roxb.	Sissoo	Leguminosae	Roadside	Tree	2	28	Indian, Bhutan, Myanmar, Pakistan, Afghanistan, Iran and Iraq (Ahmed et al. 2009b)
<i>Diplazium esculentum</i> (Retz.) Sw.	Dekhia shak	Athyriaceae	Fallow-land, Forest, Others	Herb	2	59	India, China, Taiwan, Malaysia, the Philippines and New Guinea (Siddiqui et al. 2008)
<i>Eichhornia crassipes</i> (Mart) Solms.	Kachuripana	Pontederiaceae	Others	Herb	5	06	Brazil (Raizada 2007)
<i>Eucalyptus camaldulensis</i> Dehnhardt.	Eucalyptus	Myrtaceae	Forest, Homestead, Roadside	Tree	4	32	Australia (Ahmed et al. 2009b)
<i>Eucalyptus grandis</i> Hill & ex Maiden	Eucalyptus	Myrtaceae	Forest, Homestead	Tree	4	17	Australia (Davidson et al. 1985; Ahmed et al. 2009b)
<i>Holarrhena antidysenterica</i> (L.) Wall. ex Decne.	Kurchi	Apocynaceae	Fallow-land, Forest	Shrub	3	34	India, Myanmar, Nepal, Pakistan, Sri Lanka (Ahmed et al. 2008a)
<i>Hyptis suaveolens</i> (L.) Poit.	Tokma	Labiatae	Fallow-land, Homestead, Roadside	Shrub	1	59	Tropical America (Ahmed et al. 2009a)
<i>Ipomoea aquatic</i> Forssk.	Kolmishak	Convolvulaceae	Fallow-land, Homestead, Others	Climber	2	61	Tropical Africa (Islam 1985; Ahmed et al. 2008b)
<i>Ipomoea batatas</i> (L.) Lamk.	Misti aloo	Convolvulaceae	Homestead, Others, Roadside	Climber	2	36	Native to America (Ahmed et al. 2008b)
<i>Lantana camara</i> L.	Lantana	Verbenaceae	Fallow-land, Homestead, Roadside	Shrub	5	22	Tropical and subtropical America (Binggeli et al. 1998; Raizada 2007)
<i>Melastoma malabathricum</i> L.	Ban tezpata	Melastomataceae	Fallow-land, Forest, Others	Shrub	3	41	Malaysia, New Guinea, Philippines and North Australia (Ahmed et al. 2009b)
<i>Mikania cordata</i> (Burm. f.) Robinson.	Asam lata	Asteraceae	Fallow-land, Forest, Homestead, Roadside	Climber	5	42	South and tropical America (Raizada 2007; Ahmed et al. 2008a)
<i>Mimosa pudica</i> L.	Lajjabati	Mimosaceae	Fallow-land, Forest, Homestead, Roadside	Herb	3	44	South America (Hossain et al. 2001; Ahmed et al. 2009b)
<i>Operculina turpethum</i> (L.) S. Manso	Dudkolmi	Convolvulaceae	Fallow-land, Forest, Roadside	Climber	2	06	Tropical East Africa, Polynesia, Australia. Tropical America (Ahmed et al. 2008b)
<i>Persicaria hydropiper</i> (L.)	Bish katali	Polygonaceae	Fallow-land, Forest, Homestead, Roadside	Herb	4	23	North America, Australia, French (Wunderlin et al. 2003)
<i>Pistia stratiotes</i> L.	Topapana	Araceae	Others	Herb	5	27	Tropical region (Islam 1985)
<i>Polycarpon prostratum</i> (Forssk.)	Ghima	Caryophyllaceae	Fallow-land, Homestead, Roadside	Herb	1	53	Tropical Asia, Africa. India and European counterparts (Ahmed et al. 2008b)



**Continued Appendix 1.**

Scientific name	Local name	Family	Main sources	Habit	DI <sup>1</sup>	UF <sup>2</sup> (%)	Suspected origin and reference(s)
<i>Pteris biaurita</i> L.	Dhekia	Pteridaceae	Fallow-land, Forest, Others	Herb	4	19	India, west Indies, South China, Malaysia, South Africa, Brazil (Siddiqui et al. 2008)
<i>Rumex dentatus</i> L.	Bon palong	Polygonaceae	Fallow-land, Roadside	Herb	1	33	Russia, North Africa and South East Europe (Clapham et al. 1962; Ahmed et al. 2009b)
<i>Tectona grandis</i> L. f.	Shegun	Verbenaceae	Forest, Homestead	Tree	5	12	Myanmar and India (Ahmed et al. 2010)
<i>Triumfetta rhomboidea</i> Jacq.	Bon Okra	Tiliaceae	Fallow-land, Roadside	Shrub	4	30	Tropical and sub tropical India, Sri Lanka, Malay Peninsula, China, Africa and America (Ahmed et al. 2010)
<i>Vernonia cinerea</i> (L.) Less.	Shialmutra	Asteraceae	Fallow-land, Forest, Others, Roadside	Herb	3	26	Tropical Asia, Africa, Arabia, West Indies, South America, tropical Australia and Taiwan (Ahmed et al. 2008a)
<i>Zingiber zerumbet</i> (L.) Smith	Bon ada	Zingiberaceae	Fallow-land, Forest	Herb	3	27	India, Malaysia, Nepal, Sri Lanka and Caribbean (NPDC 2010; Ahmed et al. 2008c)

**Notes:** DI<sup>1</sup> (**Degree of invasiveness**, based on peoples' perception) means that particular species was fall under this category; "1" is **naturalized** (Species have self sustaining and spreading capability without human support, but they don't necessarily hamper other plant's growth), "2" is **introduced** (Species are planted and may or may not become naturalized), "3" is **possibly invasive** (Species are locally regenerating but the extent of spread may or may not be limited), "4" is **moderately invasive** (Species are spreading at moderate densities and are considered to have some immediate problem), "5" is **highly invasive** (Species become dominant or co-dominant in the invaded region and are considered a threat to the native flora and ecosystem). UF<sup>2</sup> (**Use frequency**) is use percentage of invasive medicinal plants in relation to the total number of times.

**Appendix 2: Traditional uses and preparations of some common medicines in the study areas**

Scientific name	Parts used	Curative uses <sup>3</sup>	Using pattern
<i>Achyranthes aspera</i> Linn.	Whole plant	Dysentery, piles, rheumatism, stop bleeding, skin diseases	Roots of 4 g are crushed well and taken until patients are cured. Pills (1-2mg each) are made out of crushed leaves and each pill is applied twice daily.
<i>Ageratum conyzoides</i> L.	Leaf	Cut and wounds	Crushed leaves are used directly on cuts and wounds.
<i>Albizia falcataria</i> L.	Bark, leaf, root	Eye disease, headache, inflammation, teeth ache	Tender leaves, bark and roots are rubbed and mixed with onion and salt, which is taken with rice. Paste made from leaves is used for inflammation.
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Leaf	Eye disease, liver problem	Leaves with abundant vitamin are cooked and taken as vegetables.
<i>Argemone mexicana</i> Linn.	Leaf, seed, stem	Headache, jaundice, skin diseases, spleen disease	Juice made from leaves and stem is used in jaundice and skin diseases; oil from seeds is used for spleen disease and headache.
<i>Bacopa monniera</i> (L.) Pennel	Leaf, seed	Asthma, HD, mental depression	Juice from leaves and seeds is used in curing heart diseases, asthma, and mental depression.
<i>Bryophyllum pinnatum</i> (Lamk.) Oken	Leaf	Cough, joint pain, liver problem, urinary problem	Fleshy leaves are rubbed to extract juice, which is fed with sugar. Juice is drunk 2-3 times in a day.
<i>Cassia occidentalis</i> L.	Bark, leaf, root	Cough, cold ailments, diarrhea, diabetes, stop bleeding, skin diseases	Juice made from bark and leaves is used for diarrhea and stop bleeding. Leaves and roots are also used in skin disease, cough, and cold alignment. Leaf powder is taken with tea or milk orally 2 times per day until improvement occurs.
<i>Centella asiatica</i> (L.) Urban	Whole plant	Cardiac tonic, diarrhea, dysentery, gastric pain, liver problem	Juice made from whole plant is used with honey. Sometimes whole plant is eaten after cooking with water and salt.
<i>Chromolaena odorata</i> (L.) King & Robinson	Leaf	Stop bleeding	Paste is made from the leaves and placed over the affected place.
<i>Clerodendrum viscosum</i> Vent.	Whole plant	Ear ache, scabies, skin diseases, worms	The decoction of leaves and roots is heated slightly and the warm liquid is poured into the ear in case of ear pain. Bath with leaf boiled water is taken for scabies, skin disease and worms.
<i>Croton bonplandianus</i> Baill.	Flower, leaf	Anti-allergic, asthma, headache, skin diseases, teeth ache	Paste is made from the leaves and flowers and placed over the affected place. Juice made from leaves is sometimes used with coconut oil for headache.
<i>Cuscuta reflexa</i> Roxb.	Whole plant	Fever, hair fall, skin diseases, rheumatism	Juice is used as medicine. Oil made from this plant is used externally for rheumatism.
<i>Cyathea gigantea</i> Wall	Whole plant	Insect bites	Paste is made from the leaves or roots and used to prevent insect bites. Sometimes whole plant is used as a talisman to protect the body from evil spirits by the local herbal practitioner.
<i>Cynodon dactylon</i> (L.) Pers.	Whole plant	Cut and wounds, diabetes, stop bleeding, teeth ache	The paste from whole plant is placed in the wounded spot. Juice made from this grass is taken orally in the morning for diabetes.
<i>Cyperus rotundus</i> L.	Tuber	Body ache, diarrhea, fever, worms	Juice made from tuber is used in curing fever, body ache, worms and diarrhea. Some times tuber is boiled with garlic and water. Then boiled water vapor is taken orally in the morning.

**Continued Appendix 2.**

Scientific name	Parts used	Curative uses <sup>3</sup>	Using pattern
<i>Dalbergia sissoo</i> Roxb.	Bark, seed	Constipation, scabies, skin diseases, stomach problem	Bark-boiled water with table salt is prescribed to expel constipation and stomach trouble; bath with the same is given for scabies; seed oil is used for skin disease.
<i>Diplazium esculentum</i> (Retz.) Sw.	Leaf	Diarrhea, eye disease, stomach problem	Tender leaves are eaten as vegetables.
<i>Eichhornia crassipes</i> (Mart) Solms.	Leaf, stem	Antiseptic, cut and wounds, joint pain	Stems and leaves are cut and prepared juice, which is used as medicine.
<i>Eucalyptus camaldulensis</i> Dehnhardt.	Leaf, seed	Cough, cold ailments, joint pain	Leaf scent is useful for cold ailments. Oil made from leaves, roots and seeds is used in cough and joint pain.
<i>Eucalyptus grandis</i> Hill & ex Maiden	Leaf, seed	Asthma, cough, cold ailments, joint pain	Leaf scent is useful for cold ailments. Oil made from leaves, roots and seeds is used for cough, asthma, joint pain, etc.
<i>Holarrhena antidysenterica</i> (L.) Wall. ex Decne.	Bark, leaf, seed	Asthma, cut and wounds, dysentery, fever, skin diseases, worms	Bark and seed are used in skin disease, and leaves for asthma, fever, dysentery and worms. Paste made from leaves is used in affected place.
<i>Hyptis suaveolens</i> (L.) Poit.	Fruit, leaf, root	Antiseptic, fever, gastric pain, liver problem, skin diseases	Roots and leaves are crushed and made paste with water, which is placed over the affected places. Fruits are soaked into water and made juice with sugar and then taken as medicine.
<i>Ipomoea aquatic</i> Forssk.	Leaf, stem	Constipation, Eye disease, Skin diseases	Leaves together with stems are crushed well to make juice. The juice is then fed to the affected people with salt. Sometimes leaves are eaten after cooking.
<i>Ipomoea batatas</i> (L.) Lamk.	Leaf, tuber	Jaundice, liver problem, rheumatism	Leaves and tubers with abundant vitamin are eaten as vegetables for remedying all sorts of rheumatism, jaundice and liver problem.
<i>Lantana camara</i> L.	Leaf, stem	Antiseptic, joint pain, stop bleeding, skin diseases	Leaves are used for antiseptic and skin disease. Crushed leaves and stems are used for joint pain and stop bleeding.
<i>Melastoma malabathricum</i> L.	Bark, flower, leaf	Diarrhea, dysentery, skin diseases	Leaves, flowers and barks are cut and crushed for making paste and juice.
<i>Mikania cordata</i> (Burm. f.) Robinson.	Whole plant	Cut and wounds, stop bleeding	Whole plant is squeezed and the juice is used externally on the cut injury.
<i>Mimosa pudica</i> L.	Whole plant	Inflammation, jaundice, piles, scabies, skin diseases	Fresh roots (500 g) are crushed and soaked in (500 mL) water; 100-mL extract from whole plant is taken twice daily for curing piles, jaundice, scabies and skin diseases. Paste made from this plant is used for inflammation.
<i>Operculina turpethum</i> (L.) S. Manso	Tuber	Constipation	Tubers are used in constipation.
<i>Persicaria hydropiper</i> (L.)	Leaf	Antiseptic, insect bites, worms	Leaves are crushed and the extract is taken thrice daily.
<i>Pistia stratiotes</i> L.	Leaf, root	Piles	Leaves and roots are cut and crushed to make paste and then paste is used in the affected place.
<i>Polycarpon prostratum</i> (Forssk.)	Whole plant	Diarrhea, dysentery, gastric pain, ear ache, fever	Leaves are eaten as vegetables for diarrhea, dysentery and gastric pain; juice from whole plants is also drunk for fever and paste made from leaves is used to prevent ear ache.
<i>Pteris biaurita</i> L.	Leaf	Cut and wounds, scabies, stop bleeding	Paste made from tender leaves is placed over the wounds.
<i>Rumex dentatus</i> L.	Leaf, stem	Anti-allergic, Fever, Scabies	Soup is made from leaves and used to prevent fever; leaves also are used to prevent scabies. Stems are used as anti-allergic.
<i>Tectona grandis</i> L. f.	Bark, flower, fruit, root	Bronchitis, hair fall, urinary problem	Roots and fruits are used in urinary problems, and bark in bronchitis, flower oil in hair growth.
<i>Triumfetta rhomboidea</i> Jacq.	Leaf	Body ache, rheumatism	Decoction of the leaves is taken before sleep to relieve rheumatic pain and body ache.
<i>Vernonia cinerea</i> (L.) Less.	Flower, leaf	Antiseptic, skin diseases, rheumatism	Juice of leaves is used in antiseptic and skin disease; flowers are used in rheumatism.
<i>Zingiber zerumbet</i> (L.) Smith	Rhizome	Cough, cold ailments, diarrhea, dysentery, teeth ache, vomiting	Juice from rhizome is served as medicine. The rhizome is sliced and eaten directly or boiled with slight salt. Juice from rhizome is served as medicine.